

**DEPARTMENT OF AGRICULTURE
CEYLON.**

BULLETIN No. 69.

A Preliminary Report

ON

PADDY FLY INVESTIGATIONS.

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DEPARTMENT OF AGRICULTURE, CEYLON.

BULLETIN No. 59.

A PRELIMINARY REPORT ON PADDY FLY
INVESTIGATIONS MADE AT ANURADHA-
PURA FROM DECEMBER, 1920, TO
JUNE, 1921.

INTRODUCTION.



HE investigation as detailed by the Government Entomologist had two aims in view: (1) The study of the life-history and habits of the paddy fly (*Leptocoris varicornis*) ; (2) the study of the efficacy of certain methods of control.

The field work was carried out at the Dry Zone Experiment Station, Anuradhapura, and on neighbouring paddy fields, and the insectary work on the verandahs of the bungalow in which the writer lived in the town. It was unfortunate that these two important divisions of the work were located 3 miles apart. At first it was thought possible that a part of the verandah attached to the paddy store of the Economic Botanist might be utilized for the insectary work. This was very soon abandoned owing to the lack of sufficient space. There was no alternative, but to carry out the work at the bungalow, as no other suitable place was available on the Experiment Station or in its vicinity.

Field work, as already stated, was mainly carried on at the Experiment Station, and occasionally on neighbouring paddy fields. The mornings were given to this work, which consisted in experimenting with different methods of control ; supervising and assisting the bagging operations on the experimental plots, mainly those of the Economic Botanist ; the study of

the paddy fly under natural conditions (its habits, host plants, &c.); and a search for its natural enemies, i.e., parasites and predators.

Insectary work included the working out of the complete life-history of the paddy fly in detail and the life-histories of the predators (Pentatomids and Reduviids), which were found at Anuradhapura.

Much of the information gathered and incorporated in this report agrees with that of previous investigations. The data here presented as a preliminary study will show what is still necessary to be done before the work can be said to be completed.

COMMON NAMES.

The popular name "Paddy Fly" is evidently a literal translation of the Sinhalese name "goyammessa" ("goyam" = paddy plant, and " messa " = fly). The other names by which this pest is known are "Paddy Bug," "Rice Bug," and "Rice Sapper." "Vandu" is the name given to it by the Tamils.

FOOD PLANTS.

"A knowledge of the food plants of any insect is essential to its control." With this idea in view a close observation was made of all vegetation, especially grasses, which harbours the paddy fly when it is not confining its attention to maturing paddy.

Both adults and nymphs were seen to feed on the cultivated millets "kurakkan" (*Eleusine coracana*) and "amu" (*Paspalum scrobiculatum*). They were also observed to feed on *Amaranthus* spp., on *Crotalaria juncea*, and on the wild grasses which abound on the bunds and on the waste lands round the Experiment Station. This bug, which will rest on any plant that will give it shelter, may be observed at times actually to feed on the more tender parts. It has been recorded by some observers as feeding on tender shoots of sugar cane and even tea.

The list of grasses given below are those on which the bug was observed to rest. Those marked with an asterisk have proved to be food plants. *Panicum colonum* and *Cyperus polystachys* are the two most favoured.

LIST OF GRASSES FOUND ON WASTE LANDS AT
ANURADHAPURA.

- *1. *Panicum colonum* L.
- *2. *Fimbristylis diphylla* Vahl.
- *3. *Eragrostis amabilis*, W. & A.
- 4. *Chloris barbata* Sw.
- *5. *Cyperus polystachyus* Rottb.
- *6. *Panicum erus-galli* L.; "Wel-marukku," S.
- 7. *Panicum miliare* Lamk; "Meneri," S.; "Chamai," T.
- 8. *Kylinga monocephala* Rottb.
- 9. *Eleusine indica* Gærtn.
- *10. *Fuirena umbellata* Rottb.
- *11. *Ischænum ciliare* Retz.; "Rat-tana," S.
- *12. *Paspalum scrobiculatum* L.; "Amu," S.
- *13. *Fimbristylis miliacea* Vahl.; "Mudu-halpan," S.
- *14. *Cyperus rotundus* L.; "Kalanduru," S.; "Korai," T.
- 15. *Eriochola polystachya* H. B. K.
- 16. *Eragrostis interrupta* var. *dipachnoides* Stapf.
- 17. *Eragrostis tenella* var. *plumosa* Stapf.
- 18. *Cynodon Dactylon* Pers.; "Arugam-pillu," T.; Bermuda grass, Doob grass.

NATURE OF DAMAGE.

The adult paddy fly attacks the paddy soon after the flowers are fertilized and the grain is in the milky stage. It pierces the glume with its proboscis and sucks up the milky juice. Through a single puncture the bug is able to suck up all the juice in the grain till only the dry husk is left behind. This type of attack results in the yellowing of the ear, while the stem remains green. The adult has been observed to feed also upon the tender leaves and shoots of paddy, especially when the grain or flowers are not in the right stage for attack.

HABITS OF ADULTS IN THE FIELD.

The bugs appear to be most active during the cooler parts of the day. In the morning, soon after sunrise, they may be observed feeding, and are easily disturbed by the slightest movement among the growing crop. As the sun rises and it gets warmer, they become sluggish and descend to seek shelter below. They come up again to feed in the late afternoon. The average cultivator is well aware of this characteristic habit, and wisely carries on his control measures, either in the early morning or in the cool of the evening.

Cloudy weather is also favourable to the activities of the bugs. Light showers do not seem to disturb them, but they seek shelter from heavy showers or strong winds.

The adult bug, though nearly an inch in length, is not so conspicuous as one would expect it to be. The general colour of the insect varies from yellowish-green to brownish, and quite harmonizes with the colour of the grain on which it may be resting or feeding. If the bugs are present in small numbers, one has to search carefully before their presence is detected in the field. If the paddy plants are disturbed, the bugs can be seen to fly up. The adults are not very strong fliers, and their flight is limited to short distances of a few yards. While some may fly upwards on being disturbed, the larger number just drop down and seek shelter. This point should be remembered when bagging, and it is always best to return to a field half an hour after the first bagging operation has been carried out.

The characteristic odour of the bugs (emitted by both adults and nymphs from stink glands on the abdomen of the latter and the thorax of the former) is well known, and is at times very noticeable as one passes a field in which the bugs are present.

ESTIVATION.

The bugs aestivate in the adult stage during the hot months, and especially during periods of drought. During such periods they have the tendency to remain in concealment under grass, stubble, or any sort of jungly growth. Another point of interest which has been observed is that they prefer fields which are damp or water-logged to those that are dry. This observation was confirmed during bagging operations in the month of May (*vide* following table):—

Table I.—Showing Results of Bagging Operations which demonstrate that the Paddy Fly is inclined to confine itself to Fields which are Moist or Water-logged.

Date.	Habitat.	Flies captured.				Time occupied.	Remarks.
		♂	♀	Nymphs.	Total.		
1921. May 24	Grassy plot, dry-earth below	7	9	11	27	2 minutes	Both fields separated by a strip of short grass 6 feet wide. "Bagged" with an ordinary hand net between 7.30 and 8 A.M.
	Grassy plot, moist earth below ..	163	171	32	366	do.	
May 25	Grassy plot, dry ..	14	16	5	36	do.	Parallel plots separated by a bund, one slightly higher. Both bagged with a hand net in the morning.
	Grassy plot, moist ..	22	19	7	48	do.	
May 26	Grassy plot, dry ..	5	3	8	16	do.	Same plots which were bagged on May 24, 1921, also bagged before 9 A.M.
	Grassy plot, moist ..	143	157	17	317	do.	
May 27	Grassy plot, dry ..	2	2	6	10	do.	Same plots as bagged on May 24 and May 26, 1921. Bagged in the morning.
	Grassy plot, moist ..	42	50	22	112	do.	
Do.	Grassy plot, dry ..	1	4	7	15	do.	Parallel plots separated by a main drain. Bagged with a hand net in the morning.
	Grassy plot, water-logged ..	111	128	29	266	do.	

It should be mentioned that the above bagging operations were made over an area composed of small experimental plots which had been allowed to go into grass after the paddy crop had been reaped.

Periods of aestivation were observed in February when there was no rain whatever; and in May when there was a slight shower on one day only. The following table gives meteorological data for the period under investigation :—

Table II.—Meteorological.

Anuradhapura.

Month.	Temperature in Shade.				Mean of Maximum and Minimum.	Mean Relative Humidity.		Rainfall.		
	Extremes.		Mean.			From Maximum and Minimum.	From 9.30 and 3.30.	Amount.	No. of Days.	
	Maximum.	Minimum.	Maximum.	Minimum.						
1921.	°	°	°	°	°	%	%	Inches		
January ..	88.9	64.6	83.2	71.0	77.1	82	80	15.80	18	
February ..	90.9	63.3	86.4	66.6	76.5	74	62	0	0	
March ..	97.1	61.6	93.0	70.9	82.0	72	56	2.81	10	
April ..	95.4	70.1	91.4	73.9	82.6	78	70	7.53	12	
May ..	95.1	72.8	91.0	76.9	84.4	75	68	0.01	1	

MATING.

Mating was usually observed to take place in the mornings. The mating pairs face in opposite directions during copulation, this habit being characteristic of several families of Heteroptera. The period of copulation lasts from a few minutes to several hours. At times a mating pair has been observed to feed during copulation. This was observed when they happened to be mating on a ear of paddy. It has also been observed that females may lay eggs after the first mating, or they may mate two or three times before the first eggs are deposited; and further mating has been observed to occur even after the deposition of a cluster of eggs. In one experiment in the insectary, one pair within nineteen days mated on nine separate occasions, always towards the early morning, with one exception, when they were observed "in cop" before midnight. During this period the female laid 32 eggs in three separate clusters on the fourth, fifth, and twelfth days respectively.

PROPORTION OF SEXES.

This point was ascertained mainly by making counts of the adult insects captured during bagging operations. The figures obtained show a slight excess in the number of males over the females. A series of counts were made during April and May; the former month when "flies" were plentiful, and the latter when they were aestivating; and of 4,314 adults captured in different habitats, e.g., paddy fields, grassy tracts, chenas, &c., 2,223 were males and 2,091 females, or 51.5 per cent. males and 48.5 per cent. females.

Table III.—Proportion of Sexes of the Paddy Fly during April and May, 1921, at the Dry Zone Experiment Station, Anuradhapura.

Date.	Habitat.	♂	♀	Total
1921.				
April 11 ..	Grasses on the paddy area	23 ..	21 ..	44
April 11 ..	Grasses by boundary ..	61 ..	30 ..	91
April 12 ..	Grasses on paddy area ..	71 ..	30 ..	101
April 12 ..	Paddy ..	56 ..	35 ..	91
April 15 ..	Whole paddy area ..	287 ..	284 ..	571
April 15 ..	— ..	83 ..	80 ..	163
April 18 ..	Paddy ..	98 ..	87 ..	185
April 19 ..	Chena cultivation ..	27 ..	28 ..	55
April 22 ..	do.	39 ..	37 ..	76
May 9 ..	Grasses on paddy area ..	346 ..	334 ..	680
May 10 ..	do.	212 ..	209 ..	421
May 11 ..	do.	107 ..	95 ..	202
May 18 ..	Grasses on boundary ..	18 ..	13 ..	31
May 19 ..	do. *	68 ..	54 ..	122
May 24 ..	Grassy plot with dry soil ..	7 ..	9 ..	16
May 24 ..	Grassy plot with moist earth	163 ..	171 ..	334
May 25 ..	Grassy plot, dry ..	14 ..	16 ..	30
May 25 ..	Grassy plot, moist ..	22 ..	19 ..	41
May 26 ..	Grassy plot, dry ..	5 ..	3 ..	8
May 26 ..	Grassy plot, moist ..	143 ..	157 ..	300
May 27 ..	Grassy plot, dry ..	2 ..	2 ..	4
May 27 ..	Grassy plot, moist ..	42 ..	50 ..	92
May 27 ..	Grassy plot, dry ..	1 ..	4 ..	5
May 27 ..	Grassy plot, water-logged ..	111 ..	126 ..	237
		—	—	—
	Total ..	2,006	1,894	3,900
		—	—	—
May 2 ..	Paddy (muthusamba plot).	79 ..	81 ..	160
May 2 ..	do.	138 ..	116 ..	254
		—	—	—
		2,223	2,091	4,314
		—	—	—
	Per Cent. ..	51.5	45.5	

LONGEVITY OF ADULTS.

Observations were here confined to insects in the life-history experiments under both field and insectary conditions. Records were kept of the dates on which the adults emerged, and also of the dates on which they died. Under field conditions one female lived for 43 days after emergence, feeding during the whole period on *Panicum colonum*; in a second experiment one male lived for 41 days, feeding alternately on paddy (*Oryza sativa*) and on *Panicum colonum*; in a third experiment a male lived 69 days, feeding mainly on *P. colonum*. In the insectary experiments one female lived 115 days, feeding all the time on paddy; and two pairs remained alive for 105 and 113 days respectively, the former feeding chiefly on *P. colonum*, and the latter on paddy. In these insectary experiments some of the adults were still alive when the investigations were closed down on the writer's return to Peradeniya.

Table IV.—Longevity of the Paddy Fly at Anuradhapura.

Date Adults emerged.	Number of "Flies."			Food supplied.	Date last "Fly" died.	Greatest Longevity.
	♂	♀	Total.			
1921.					1921.	
Feb. 14	4	4	8	{ Grass flowers Panicum colonum	Mar. 3 (2 ♂♂) Mar. 4 (♂) Mar. 9 (♂ & ♀) Mar. 15 (♀) Mar. 18 (♀) Mar. 29 (♀) Feb. 28 ((♂)) Mar. 15 (♂ & ♀) Mar. 19 (♀) Mar. 20 ((♂)) Mar. 27 (♂) May 9 (♀) May 10 (♂♂) June 9 (♀)‡	17* 18* 23* 29* 32* 43* 14* 29* 33* 34* 41* 84† 85† 115†
Feb. 14	4	2	6	{ Grass flowers and paddy	May 10 (♂♂) June 9 (♀)‡	84† 115†
Feb. 14	2	3	5	Paddy	April 29 (♀) June 9 (♀ & 3♂)‡	84† 105†
Feb. 24	3	2	5	{ Grass flowers Panicum colonum	May 25 (♀) June 10 (♀ ♂)‡	97† 113†
Feb. 17	1	2	3	{ Paddy	May 27 (♀) June 10 (♂)‡	55† 69†
April 2	1	1	2	{ Grass flowers Panicum colonum		

* Life-history completed in field cage.

† Complete life-history worked out in insectary.

‡ Insects which were still alive when the investigation was suspended.

OVIPOSITION.

Oviposition may be said to take place at any time of the day. Judging from observations made in the insectary, oviposition was observed to take place either at night or in the early hours of the morning. Under field conditions, however, females were observed, on two occasions, to lay eggs in the morning between 8 and 9 o'clock. Preoviposition periods recorded so far have lasted from 14 days to 71 days (*vide Table V.*). The adults used in arriving at preoviposition periods were those bred from nymphs caught in the field and those obtained from the life history experiments. No data as to the oviposition period can be given at present.

Table V.—Showing Preoviposition Periods.

[Preoviposition period signifies duration of period from emergence of adult "fly" to the deposition of eggs.]

Adults emerged.	No. of Adults.		Food supplied.	Mated First Time.	First Eggs deposited.	Preovi- position Period.
	♂	♀				
1921.				1921.	1921.	Days.
Jan. 30	1	1	Paddy	..	Feb. 25	March 1 29
Feb. 14	1	1	do.	..	March 6	20
Feb. 17	1	1	do.	..	April 29	71
March 30	1	1	Grass flowers	..	April 8	April 12 13
Do.	1	1	do.	..	April 15	April 21 22
Do.	1	1	do.	..	April 18	April 22 23
Do.	1	1	do.	..	April 21	April 24 25
May 13	1	1	Paddy	..	April 23	April 27 28
May 23	1	1	Grass flowers	?	May 31	18
			and paddy	?	June 6	14

EGGS.

Eggs are invariably laid on the blades of paddy and wild grasses, or on the leaves of any plant which might give shelter and a good footing to a gravid female. Eggs are laid singly, in rows, and closely resemble grass seeds. The newly laid eggs are reddish-brown, and gradually turn a chocolate colour before they hatch. Counts were made from time to time of the numbers of eggs per egg mass collected. The table given below shows that 2,939 eggs were found in 392 egg masses, giving an average of 7.5 eggs per mass. Representing the details of these counts graphically, the "mode" is seen to be 4 eggs per mass. A curve suggests that the counts are not sufficiently large to show the normal number of eggs per mass which a female might be expected to lay.

Incubation periods in the insectary lasted from 4 to 9 days (*vide* Table VI.). The proportion of eggs which hatch in the field is high. Judging from careful observations made in the field of 1,310 eggs deposited, 1,064 hatched and 246 did not hatch ; this works out as a percentage of 81.2 hatched (*vide* Table VII.).

Table VI.—Period of Incubation of the Eggs of Paddy Fly at Dry Zone Experiment Station, Anuradhapura.

Eggs deposited.		Eggs hatched.		Incubation Period.
	1921.		1921.	Days.
March 1	..	March 10	..	9
March 3	..	March 12	..	9
March 6	..	March 15	..	9
April 21	..	April 27	..	6
April 22	..	April 30	..	8
April 24	..	May 1	..	7
April 29	..	May 7	..	8
May 27	..	May 31	..	4
May 28	..	June 1	..	4
May 29	..	June 2	..	4
June 4	..	June 9	..	5

Table VII.—Table showing Proportion of Eggs which Hatch in the Field.

Date.	Number of Eggs deposited.	Number of Eggs found hatched out.	Food Plant.
December 20 ..	6	3	Crotalaria sp.
December 15-20	8	8	Grass
Do. ..	6	6	do.
Do. ..	4	4	Paddy
Do. ..	5	4	Grass
Do. ..	4	4	Crotalaria
Do. ..	7	4	Paddy
Do. ..	4	4	Crotalaria
Do. ..	23	23	Paddy
Do. ..	10	10	Crotalaria
Do. ..	19	17	Paddy
Do. ..	4	4	Crotalaria
January ..	74	66	Paddy
January 27 ..	156	140	do.
February ..	49	41	do.
March ..	52	46	do.
April ..	53	36	do.

Table VII.—*contd.*

Date.	Number of Eggs deposited.	Number of Eggs found hatched out.	Food Plant.
May 2	.. 79	.. 69	Paddy
Do.	.. 30	.. 26	Grass
Do.	.. 43	.. 31	Paddy
May 3	.. 16	.. 13	do.
Do.	.. 23	.. 19	do.
Do.	.. 80	.. 60	do.
Do.	.. 76	.. 58	do.
Do.	.. 106	.. 72	do.
May 4	.. 17	.. 10	do.
Do.	.. 88	.. 78	do.
Do.	.. 93	.. 76	do.
May 9	.. 86	.. 61	Grass
May 11	.. 89	.. 71	do.
	1,310	1,064	

Number of eggs deposited : 1,310.

Number of eggs hatched : 1,064, or 81.2 per cent.

Number of eggs did not hatch : 243, or 18.8 per cent.

NYMPHS.

The nymphs are greenish insects with rather long legs. On emerging they are gregarious, and tend to remain close to the eggs from which they emerged. They begin to feed within an hour or two after hatching. Soon after the first moult they travel upwards to a ripening ear, where they may remain gregarious again till they have moulted for the third and fourth time. Once they have reached this stage, they commence to wander about by themselves and live a more or less solitary existence. They are most active after the fourth moult. Like their parents, they will feed on tender stems and leaves, also on paddy or any grain, provided it is in its milky stage.

PERIODS OF NYMPHAL STAGES.

Nymphs moult five times before they reach the imago or adult stage. In a long series of experiments (both in the field and in the insectary), the first instar, or feeding period between moults, occupied 2-3 days; the second instar, 2-4½ days; the third instar, 3-5 days; fourth instar, 3-7 days; fifth instar, 4-9 days; and a total nymphal period from a minimum of 16 days to a maximum of 25 days. Normal period or "mode" is 19½ days.

Table VIII. is appended to show details of figures.

Table VIII.—Duration of Nymphal Instars and Periods of Development of *Leptocoris varicornis* at Anuradhapura, April to June, 1921.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Hatching									
First Mouth	16, IV. A.M.	16, IV. A.M.	13, IV. A.M.	16, IV. A.M.	21, IV. A.M.				
First Instar	15, IV. P.M.	13, IV. P.M.	18, IV. P.M.	18, IV. P.M.	25, IV. A.M.	23, IV. A.M.	23, IV. A.M.	23, IV. A.M.	23, IV. A.M.
Second Mouth	20, IV. P.M.	20, IV. P.M.	20, IV. P.M.	20, IV. P.M.	25, IV. A.M.				
Second Instar	23, IV. P.M.	23, IV. P.M.	23, IV. P.M.	23, IV. P.M.	26, IV. A.M.				
Third Mouth	29, IV. P.M.	29, IV. P.M.	29, IV. P.M.	29, IV. P.M.	27, IV. A.M.				
Third Instar	29, IV. P.M.	29, IV. P.M.	29, IV. P.M.	29, IV. P.M.	27, IV. P.M.				
Fourth Mouth	6, V. P.M.	6, V. P.M.	30, IV. P.M.	1, V. A.M.	2, V. A.M.	3, V. A.M.	4, V. A.M.	5, V. A.M.	5, V. A.M.
Fourth Instar	6, V. P.M.	6, V. P.M.	6, V. P.M.	6, V. P.M.	6, V. A.M.				
Fifth Mouth	6	7	7	6	7	8	9	10	11
Fifth Instar									
Total	19 $\frac{1}{4}$	20 $\frac{1}{4}$	20 $\frac{1}{4}$	20 $\frac{1}{4}$	21 $\frac{1}{4}$	18	20	20	22
Hatching									
First Mouth	21, IV. A.M.	21, IV. A.M.	23, IV. A.M.						
First Instar	23, IV. P.M.	23, IV. P.M.	25, IV. P.M.	25, IV. P.M.	25, IV. A.M.				
Second Mouth	25, IV. P.M.	25, IV. P.M.	25, IV. P.M.	25, IV. P.M.	28, IV. A.M.				
Second Instar	28, IV. P.M.	28, IV. P.M.	28, IV. P.M.	28, IV. P.M.	29, IV. A.M.				
Third Mouth	3, V. A.M.	3, V. A.M.	2, V. A.M.	2, V. A.M.	2, V. A.M.	3, V. A.M.	3, V. A.M.	3, V. A.M.	3, V. A.M.
Third Instar	7, V. A.M.	7, V. A.M.	6, V. P.M.						
Fourth Mouth	15, V. P.M.	15, V. P.M.	11, V. P.M.	12, V. P.M.					
Fourth Instar	15, V. P.M.	15, V. P.M.	11, V. P.M.	12, V. P.M.					
Fifth Mouth	16	8	6	5	5	6	6	6	6
Fifth Instar									
Total	23 $\frac{1}{4}$	24 $\frac{1}{4}$	16 $\frac{1}{4}$	10 $\frac{1}{4}$					

Table VIII.—*contd.*

	19.	20.	21.	22.	23.	24.	25.	26.	27.
Hatching									
First Molt	25, IV. A.M.								
First Instar	27, IV. A.M.	27, IV. A.M.	27, IV. A.M.	27, IV. P.M.					
Second Molt	2, V. A.M.								
Second Instar	30, IV. A.M.								
Third Molt	4, V. A.M.	4, V. P.M.							
Third Instar	5, V. A.M.	5, V. P.M.							
Fourth Molt	6, V. A.M.	6, V. P.M.							
Fourth Instar	7, V. A.M.	7, V. P.M.							
Fifth Molt	8, V. A.M.	8, V. P.M.							
Fifth Instar	9, V. A.M.	9, V. P.M.							
Total	19½	19½	19½	20½	20½	20½	20½	21	21½
	28.	29.	30.	31.	32.	33.	34.	35.	36.
Hatching									
First Molt	25, IV. A.M.								
First Instar	27, IV. P.M.								
Second Molt	2, V. A.M.								
Second Instar	3, V. A.M.	3, V. P.M.							
Third Molt	4, V. A.M.	4, V. P.M.							
Third Instar	5, V. A.M.	5, V. P.M.							
Fourth Molt	6, V. A.M.	6, V. P.M.							
Fourth Instar	7, V. A.M.	7, V. P.M.							
Fifth Molt	8, V. A.M.	8, V. P.M.							
Fifth Instar	9, V. A.M.	9, V. P.M.							
Total	21½	23	23	16	16	16	16	17	17½

Table VIII.—*contd.*

Table VIII.—*contd.*

	55.	56.	57.	58.	59.	60.	61.	62.	63.
Hatching	1, V. A.M.								
First Molt	4, V. A.M.								
First Instar	3, V. A.M.								
Second Molt	6, V. P.M.								
Second Instar	2 $\frac{1}{2}$, V. P.M.								
Third Molt	9, V. P.M.								
Third Instar	3, V. P.M.								
Fourth Molt	13, V. P.M.								
Fourth Instar	4, V. P.M.								
Fifth Molt	20, V. P.M.								
Fifth Instar	7, V. P.M.								
Total	10 $\frac{1}{2}$								
	64.	65.	66.	67.	68.	69.	70.	71.	72.
Hatching	10, V. A.M.								
First Molt	12, V. A.M.								
First Instar	3, V. A.M.								
Second Molt	15, V. A.M.								
Second Instar	3, V. A.M.								
Third Molt	10, V. A.M.								
Third Instar	4, V. A.M.								
Fourth Molt	23, V. P.M.								
Fourth Instar	4 $\frac{1}{2}$, V. P.M.								
Fifth Molt	28, V. P.M.								
Fifth Instar	4, V. P.M.								
Total	10 $\frac{1}{2}$								

Table VIII.—*contd.*

	73.	74.	75.	76.	77.	78.	79.
Hatching	14, V.A.M.	14, V.A.M.	14, V.A.M.	14, V.A.M.	14, V.A.M.
First Molt	..	12, V.A.M.	17, V.A.M.				
First Instar	..	3	8	3	3	3	3
Second Molt	..	16, V.A.M.	19, V.P.M.	19, V.P.M.	20, V.A.M.	20, V.A.M.	20, V.A.M.
Second Instar	..	4	2 $\frac{1}{2}$	2 $\frac{1}{2}$	3	3	3
Third Molt	..	20, V.P.M.	22, V.P.M.	22, V.A.M.	23, V.P.M.	23, V.P.M.	23, V.P.M.
Third Instar	..	4 $\frac{1}{2}$	3	3	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$
Fourth Molt	..	27, V.P.M.	26, V.P.M.	26, V.P.M.	27, V.P.M.	28, V.A.M.	28, V.P.M.
Fourth Instar	..	7	4	4	4 $\frac{1}{2}$	4 $\frac{1}{2}$	5
Fifth Molt	..	3, VI.P.M.	30, V.P.M.	31, V.P.M.	31, V.P.M.	1, VI.P.M.	2, VI.P.M.
Fifth Instar	Total	7	4	6	4	4 $\frac{1}{2}$	4 $\frac{1}{2}$
	25 $\frac{1}{2}$	16 $\frac{1}{2}$	17 $\frac{1}{2}$	17 $\frac{1}{2}$	18 $\frac{1}{2}$	18 $\frac{1}{2}$	19

SEASONAL HISTORY.

A thorough knowledge of the seasonal history of an insect is best arrived at after continued observations have been made in one district during a period of at least one year. The observations on this are incomplete because they extend only over a period of six months.

In the Anuradhapura District paddy fly is said to be worst during the months of June and July and October and November. (Data collected by Summers show that paddy fly is worst at Anuradhapura from January to May, and again during the months of July and September.) At the Experiment Station, where paddies were ripening all the year round, each maturing stage was accompanied by an "invasion" of paddy fly.

NATURAL ENEMIES.

The recorded enemy of the paddy fly—the six spotted tiger beetle (*Cicindela sexpunctata*)—was not found at Anuradhapura.

Egg parasites (*Proctotrypidae*) were obtained, but rarely. Adults which emerged from egg masses in the insectary were liberated in the fields, while a few specimens were forwarded to Peradeniya for identification.

The Pentatomid (*Asopus malabaricus*), whose predatory habits in relation to paddy fly were hitherto unrecorded, was observed to predate on an adult *Leptocoris* in the field. This beneficial bug was captured, and in the insectary it was observed to feed on two or three species of insects and even on a *Curculionid*. Luckily, the bug captured happened to be a female, and lived in captivity for 49 days during which period it laid 285 eggs in 9 masses. Nymphs of *A. malabaricus* were observed to predate freely on both adults and nymphs of *Leptocoris*. The life-history of this bug was worked out, and the data gathered will be published later. Adults and nymphs of this bug are found frequently among the growing paddy, and doubtless play an important part in checking the increase of paddy fly.

Two species of Reduviids—*Harpactor fuscipes* and *Irantha* sp.—were also observed to be predaceous on both nymphs and adults of *Leptocoris*.

ARTIFICIAL CONTROL.

Charms, &c.—A study of these quaint practices was made whenever the opportunity arose. Beyond the fact that they are superstitions and something in which the majority of cultivators have great faith, nothing more could be learnt.

These devices are usually accompanied by the burning of fires, aromatic substances, &c., which may serve to drive away the paddy fly temporarily to adjacent fields, but appear to have no effect in reducing the numbers of the pest. Beyond collecting information as to the actual practices adopted, no special study was made.

Cultural Methods.—The cultural methods suggested by the Entomologist in his leaflet were followed during the investigation with the co-operation of the staff at the Dry Zone Experiment Station. It must be mentioned here that the keeping of bunds and adjoining lands free of wild grasses and weeds is not sufficient. Fields soon after harvesting should not be allowed to go into grass. This occurred at the Experiment Station, where fields vacated by the Economic Botanist after the "yala" were allowed to go into grass (due to shortage of labour), and these plots turned to be a typical breeding ground for the bug. It was in these plots that the bugs were also seen to aestivate during the dry months.

Bagging.—Large field nets were not experimented with at Anuradhapura. These field nets are only effective when worked on grassy tracts *against* the wind, and especially during such periods when the insects are aestivating. In paddy fields, where the bunds (for walking on) are far apart, the use of large nets is impracticable. They are liable to do more damage to the paddy crop than the paddy fly itself. Hand nets gave very good results at Anuradhapura. "Flies" captured were emptied into large tins containing water with a film of kerosine. Killing the "flies" in this way enabled the investigation to ascertain the actual number of "flies" captured in a single "catch" and to arrive at the proportion of the sexes captured in different habitats. Results of bagging operations are tabulated in Tables IX. and X.

Table IX.—Results of Bagging Operations with a Hand Net at Anuradhapura.

Date.	Time.	Period occupied.	Number captured.
1931.			
Jan. 14 ..	8.30-9 A.M.	.. $\frac{1}{2}$ hour	.. 84*
Jan. 15 ..	8-9 A.M.	.. 1 hour	.. 226
Jan. 16 ..	10.15-10.45 A.M.	.. $\frac{1}{2}$ hour	.. 37
Jan. 17 ..	8-9 A.M.	.. 1 hour	.. 122
Jan. 19 ..	7-11 A.M. and 1.30-5 P.M.	7 $\frac{1}{2}$ hours	.. 338
Jan. 20 ..	7.30-8 A.M.	.. $\frac{1}{2}$ hour	.. 22

* Only one net was used at one time for all the above operations.

Table IX.—*contd.*

Date.	Time.	Period occupied.	Number captured.
1921.			
Jan. 20	7-11 A.M.	4 hours	50
Jan. 21	7.15-7.45 A.M.	½ hour	27
Jan. 21	7-11 A.M.	4 hours	43
Jan. 21	2-5 P.M.	3 hours	25
Jan. 22	7.15-7.45 A.M.	½ hour	13
Jan. 22	7-11 A.M.	4 hours	37
Jan. 24	7-11 A.M.	4 hours	30
Jan. 24	2-5 P.M.	3 hours	33
Jan. 25	6.45-8.45 A.M.	2 hours	55
Jan. 25	2-5 P.M.	3 hours	35
Jan. 26	7-11 A.M.	4 hours	27
Jan. 27	6 A.M.-6.45 A.M.	½ hour	362
Jan. 27	7.30-8 A.M.	½ hour	231
Jan. 28	7.15-7.45 A.M.	½ hour	39
Jan. 28	7-11 A.M.	4 hours	60
Jan. 31	7-11 A.M.	4 hours	33
Feb. 5	8-11 A.M.	3 hours	11
Feb. 7	8-11 A.M.	3 hours	5
Feb. 7	2-4.30 P.M.	2½ hours	478
Feb. 8	7.30-11 A.M.	3½ hours	241
Feb. 24	8-10 A.M.	2 hours	50
Feb. 26	8-11 A.M.	3 hours	14
Mar. 4	7-11 A.M. and 2-4 P.M.	6 hours	275
April 11	7-15-7.30 A.M.	15 minutes	45
April 12	9-15-9.45 A.M.	30 minutes	101
April 14	7-30-7.45 A.M.	15 minutes	135
April 15	7-15-7.30 A.M.	15 minutes	163

Ropes and Winnows.—Ropes (1) saturated with kerosine or (2) smeared with Ostico,* and dragged across affected fields, did not give sufficiently encouraging results to warrant their being advised as effective methods of control. Counts made from bagging before and after these ropes were used did not show any appreciable decrease in the number of bugs captured.

Ostico when applied thickly on an ordinary paddy winnow gave very good results. For instance, during the comparative trials between the winnow and the hand net, on one occasion, within a period of 5 minutes, the winnow was able to capture

* Ostico is a very sticky substance manufactured by McDougall Bros.; and a sample was supplied by the local agents for experiment in a general way. It was quite effective when smeared thickly on paddy winnows as indicated elsewhere, but can hardly be recommended for general use by paddy cultivators on account of its high cost as compared with the various sticky juices used locally.

355 adults, while the hand net, within a similar period and on a parallel field, was able to catch 542 adults. Further figures are shown in Table X. :—

Table X.—Comparative Trials : Bagging with a Hand Net vs. Ordinary Winnow smeared with Ostico.

Date. 1921.	Winnow.	Hand Net.	Time occupied. Intervals.
Feb. 3	11	21	½ hour
Feb. 4	6	12	do.
Feb. 7	8	13	do.
Feb. 10	18	38	do.
Feb. 11	19	39	do.
Feb. 11	5	24	do.
Feb. 12	19	41	1 hour
Feb. 23	9	18	½ hour
March 15	8	58	1 hour
March 17	7	35	½ hour
April 11	5	44	5 minutes
May 3	355	542	do.
May 9	642	780	15 minutes
May 10	319	421	do.

Baits.—Lefroy records that paddy fly was attracted to crushed sugar cane when placed on the bunds. This was tried in December, 1920, when paddy fly was plentiful, but no "flies" were attracted.

The Philippine bait of putrid meat as suggested by Acre* was tried several times and proved a failure. "This discovery," states Acre, "demonstrates that both the adults and the immature bugs are attracted to the smell of putrid meat, and recognize it from a considerable distance and immediately investigate the source." In a recent report† this bait is again recommended.

At Anuradhapura twelve experiments were made to test the efficacy of this bait. Putrid meat, without being poisoned, was placed in muslin bags and suspended in both paddy and grassy fields which harboured the paddy fly. The bags were usually hung out at 7 o'clock in the morning. With one exception, when six to eight paddy flies were found resting on one of the bags—and this occurrence may be regarded as accidental—not a single paddy fly was observed to have been attracted to the baits. It was noticed that flies of various kinds were attracted to the bait in large numbers and were continually buzzing about it. These may have kept away the paddy fly.

* Seventeenth Annual Report of the Bureau of Agriculture, Philippine Agri. Review, Second Quarter, 1919, Vol. XII., No. 2, p. 92.

† "The Rice Bug (*Leprocoris acuta*) in the Philippines," by Leopold B. Uichanco, Philippine Agri. Review, Vol. XIV., No. 1, First Quarter, 1921, pp. 87-125.

SUMMARY.

1. This article presents certain data obtained during a season's (six months) stay at Anuradhapura in order to investigate (i.) the life-history and habits of the paddy fly; and (ii.) the efficacy of certain methods of control.

2. The food plants of the insect were examined, and a list is given of the wild grasses on which "fly" is found to live and breed. *Panicum colonum* and *Cyperus polystachyus* are the two most favoured. The "fly" may at times suck the juice from the tender parts of any plant.

3. The nature of the damage done to paddy is to suck the sap out of the grain when in the milky stage, causing the ear to be emptied of its contents and to put on a yellowish appearance, while the rest of the plant remains green.

4. The bug is most active in the cooler parts of the day, both morning and evening. Observations in the night have yet to be made.

5. The adult bug is not conspicuous in the field, as its general colour harmonizes with the grain on which it feeds. The adults are not strong fliers; on being disturbed, they may, more often than not, drop down and seek shelter below.

6. The bugs aestivate in the adult stage during the hottest and driest parts of the year. They remain in concealment in any sort of weedy growth or low jungle. Preference is shown to damp or water-logged fields or swamps.

February and May were the driest and hottest months in Anuradhapura during the investigation. With showers of rain the bugs commence to feed actively, copulate, and lay eggs.

7. Mating is generally done in the mornings. The period of copulation may last from a few minutes to 4-5 hours. Mating may occur two or three times before the eggs are deposited, and may occur between ovipositions.

8. The difference in the proportion of sexes is not great. From a series of counts made from different habitats, only a slight excess of males is shown.

9. Adults can live as long as 69 days under field conditions. In captivity some have been found to live 105 to 115 days, or nearly four months.

10. Oviposition may take place at any time of the day. Preoviposition periods have lasted from 14 to 71 days. (One female was observed to lay 32 eggs in three separate clusters.)

11. Eggs resemble grass seeds, and are laid singly in rows on blades of grass, paddy, or leaves of any plant on which a female may rest. Average number of eggs in a mass is 7.5. The actual number of eggs which can be laid by a single female was not ascertained. Incubation periods in the insectary lasted from four to nine days. Over 80 in every 100 eggs hatch out under field conditions.

12. Nymphs are greenish insects with rather long legs. They feed within an hour of their hatching and moult five times during a normal nymphal period of 19 $\frac{1}{2}$ days before they reach the adult stage.

13. The tiger beetle (*Cicindela sexpunctata*) was not observed. Egg parasites (*Proctotrypidæ*) were found, also a predaceous Pentatomid (*Asopus malabaricus*) and two Reduviid predators, i.e., *Harpactor fuscipes* and *Irantha* sp.; these records of predators are here made for the first time.

14. Large field nets were not experimented with, as they are considered impracticable. Hand nets give good results. Winnows smeared with any sticky substance give equally good results. Ropes saturated with kerosine or smeared with Ostico (a very sticky substance) and dragged across affected fields do not give encouraging results.

15. Crushed sugar cane as suggested by Lefroy in India, placed on bunds as a bait, was not found to attract paddy fly. The Philippine bait, which consists of putrid meat hung out in muslin bags, attracted no paddy flies.

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June 5, 1922. Assistant in Entomology.

